Performance Evaluations: Barhams Farm, AA Dairy, and Colorado Pork

John H. Martin, Jr.
Hall Associates
Georgetown, DE

Background

- Barhams Farm—A 4,240 head farrow-to-wean operation located in central NC
- AA Dairy—A 550 cow operation located in the southern tier of upstate NY
- Colorado Pork—A 5,000 sow farrow-to wean operation located in southeastern CO

Background (continued)

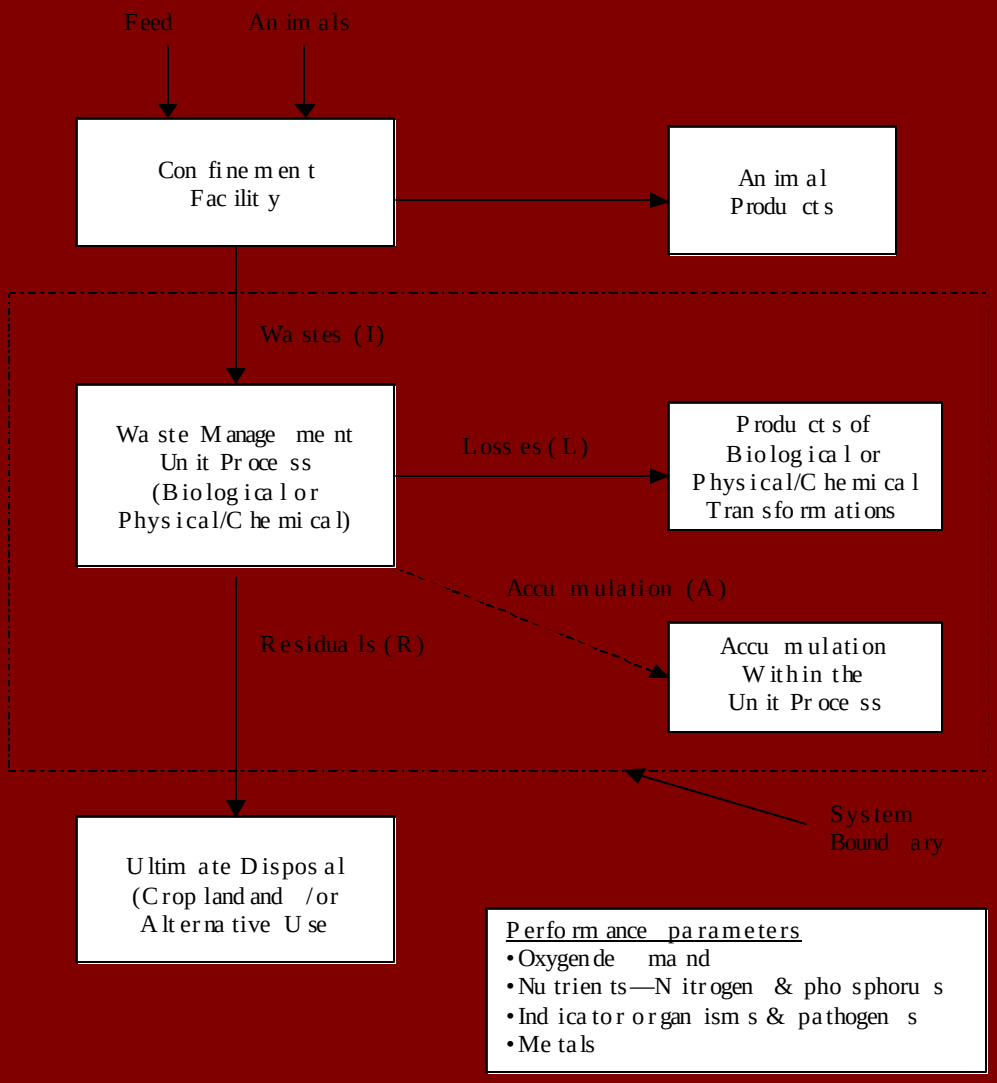
- Barhams: Pit recharge, covered unheated lagoon, effluent storage pond
- AA Dairy: Scraped free-stall alleys, mesophilic plug-flow digester, coarse solids separation, effluent storage pond
- Colorado Pork: Pull plug pits, mesophilic mixed digester, effluent evaporation pond

Methodology

- Evaluations of performance were based on measured concentrations of parameters of interest in combination with mass flow estimates.
- Data collection occurred over a 12-month period of steady-state operation with two sampling episodes per month.

Methodology (continued)

- When possible, the ability to account for fixed solids was used to test the validity of results of materials balances.
- Measured biogas production and methane content were used to test the validity of TVS and COD mass balances.



Where: L = I - (R + A)
(I and R are measured and
L and A are estimated)

A General Observation:

- Variation among grab samples of influent to digesters to characterize performance can be substantial.
- Therefore, the credibility of results of performance evaluations based on a small number of sampling episodes should be questioned.

Significant General Findings:

- For both dairy and swine manures, the stociometric prediction the approximately 5.6 ft^3 of methane is produced per lb of COD destroyed was confirmed.
- It appears, however, that the rate of methane production per lb of TVS destroyed for dairy manure is higher than that for swine manure (12.3 ft^3 versus 8.2 ft^3 per lb TVS_d).

Significant General Findings (continued)

- Ammonia emissions do not appear to be either decreased or increased by anaerobic digestion.
- The ammonia concentration in biogas appears to be insignificant.

Significant General Findings (continued)

- Over design in anticipation of expansion makes anaerobic digestion appear to be less attractive economically.
- Maximizing the thermal efficiency of the conversion of biogas to electricity is important.

Significant findings—Barhams

- The covered lagoon effluent storage pond was not a significant source of odors.
- There is significant seasonal variation in covered lagoon biogas production limiting the fraction of biogas generated electricity that can be used on-site.

Significant findings—Barhams (continued)

- Avoided methane emission was 99 lb per year per unit of confinement capacity (~ 210 tons per year for the farm).
- The covered lagoon-storage pond was found to be superior to a conventional lagoon-storage pond and two single cell lagoons with respect to indicator organism and pathogen reductions.

Significant findings—AA Dairy

- Anaerobic digestion resolved odor issues with the local community.
- Total carbon dioxide emissions were reduced by 3.6 tons per cow-year.
- An average 99.9% reduction in fecal coliforms and a 99% reduction in *M. avium paratuberculosis* was achieved.

Significant findings—Colorado Pork

- Reduction of odors to below Colorado's maximum allowable level.
- Reduction in hydrogen sulfide emissions: at least 6,000 lb per year.
- Reduction in methane emissions: at least 144 tons per year.

Significant findings—Colorado Pork (continued)

- Interconnection with the local utility is critical for maximizing gross income from biogas produced.
- Thermal conversion efficiency, biogas to electricity, was only 22% due to the inability to use all of the biogas produced.

Significant findings—Colorado Pork (continued)

- As evaluated, digestion reduced net farm income by $931 or $0.19 per sow confined.
- Subsequent interconnection should be increasing net farm income significantly.

Current needs:

- The necessary data to allow identification of process design parameters that optimize process performance.
- Better delineation of capital and operating and maintenance costs.

Acknowledgements